GUIDANCE FOR REVIEW OF

TWRS PRIVATIZATION CONTRACTOR

RADIATION EXPOSURE STANDARDS FOR WORKERS

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Introduction

Dose standards for both facility workers and co-located workers for unlikely and extremely unlikely events are derived by the Tank Waste Remediation Systems (TWRS) Privatization Contractors. This guidance presents considerations for reviewers to assess the contractors' proposed radiation dose standards. This guidance does not impose any new requirements on the TWRS Privatization Contractors.

Basis for Acceptable Dose Standards

The two principal criteria that form the basis for accident dose standards are defined in the *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors* (DOE/RL-96-0006).

1. Criterion:

> "The risk, to workers in the vicinity of the Contractor's facility, of fatality from radiological exposure that might result from an accident should not be a significant contributor to the overall occupational risk of fatality to workers."[1]

Discussion:

> According to EH-12-94-01, Vol. 1, the risk of a fatality to workers in U.S. industries ranges from about 0.3 X 10^{-4} in the "safest" industry to 4 X 10^{-4} in the "least safe" industry. A value of 1 X 10^{-4} can be considered "average." Using 10% as the threshold for a significant contributor, **an overall risk of fatalities associated with facility accidents of 1 X 10^{-5} per year** would result in an accident not being a significant contributor to

[1] DOE/RL-96-0006, page 4 of 23, Section 3.1.3

the overall occupational risk of fatality to workers. This goal is consistent with guidance contained in the *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities* (EH-12-94-01, Volume 1).

2. Criterion:

"The risk, to an average individual in the vicinity of the Contractor's facility, of prompt fatalities that might result from an accident should not exceed 0.1% of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed."[2]

Discussion:

The accidental death rate in the U.S. is approximately 40 per 100,000 per year, or about 4×10^{-4} per year. 0.1% of this value is 4×10^{-7} per year. Thus, for the most probable extremely unlikely event (accident probability of 1×10^{-4}), the probability of a prompt fatality would need to be 0.4% to be less than the 4×10^{-7} per year criterion. Given that an acute radiation dose of approximately 100 rem carries almost no risk of prompt death[3], it is reasonable to conclude that a worker radiation dose standard of 100 rem would satisfy the criterion. A worker radiation dose standard greater than 100 rem would need to be justified.

Guidelines for Evaluation of Submittals

Extremely Unlikely Events (Probability 10^{-4} to 10^{-6}): For events in this probability range, doses to both facility workers and co-located workers should not exceed 100 rem. Contractors will need to justify worker dose standards above 100 rem for credible (i.e., probability of 1×10^{-6} or greater) accidents. Any proposed standards that were to include different values for facility workers versus co-located workers would need to be justified.

[2] DOE/RL-96-0006, page 4 of 23, .Section 3.1.2
[3] EH-12-94-01, Vol. 2, Appendix B.

Unlikely Events (Probability 10^{-2} to 10^{-4}): For events in this probability range, an acceptable dose standard will range between the dose standard prescribed for the normal or anticipated events (5 rem per year) and the dose standard for extremely unlikely events (100 rem per year being an acceptable standard without additional justification). One acceptable approach would be to determine the annual radiation doses across the probability range of 10^{-2} to 10^{-4} that correspond to a fatality risk of approximately 1 X 10^{-5} per year and set the worker dose standard at or below this level. The radiation doses can be derived using accepted radiation risk factors, as presented in the BEIR V report (NAS 1990) and as adopted by both the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). Specifically, at doses below 10 rem, a risk factor of 4 X 10^{-4} fatal cancers per rem can be applied for workers. At doses at 10 rem and above, a risk factor of 1 X 10^{-3} fatal cancers per rem can be applied for workers. Based on this approach, a curve representing a continuous fatality risk of 1 X 10^{-5} is illustrated in Figure 1 from 5 rem to 100 rem, which corresponds to event probabilities from 5 X 10^{-3} to 1 X 10^{-4}.

A second acceptable approach would be to establish an **average** dose standard (single value) across the probability range of 10^{-2} to 10^{-4} that results in an **average** fatality risk of approximately 1 X 10^{-5} per year. The corresponding value for this range is a constant worker dose standard of slightly less than 10 rem.

The reviewer should also assess whether the assumed average annual fatality risk could significantly exceed 1 X 10^{-5} for events in this category given the probability distribution of accident scenarios provided by the contractor. The assessment should assume that a constant dose standard above 10 rem would not meet this criterion, unless the contractor can provide justification as to why there would be relatively few accident scenarios at the higher end of this range (e.g., with probabilities more likely than 1 X 10^{-3}). Similarly, the assessment should assume that a dose curve with values substantially higher than those in Figure 1 would not meet this criterion without similar justification.

Total Facility Risk: It is important to recognize that the criterion of 1 X 10^{-5} represents the annual fatality risk from **all** facility accidents. In other words, if there are multiple, independent accidents each with associated risks approaching this value, it is likely that the overall risk associated with the facility could be considered appreciably greater than 1 X 10^{-5}. If enough independent

accidents were possible, the total facility risk could exceed 1 X 10^{-4}. A total facility risk of 1 X 10^{-4} would only be average in terms of accident safety. Thus, the reviewers should look for evidence in the submittals that the dose standards for unlikely events represent the totality of accidents within that range as opposed to standards for each individual accident.

References

1. *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, Volume 1: Main Report, EH-12-94-01, U. S. Department of Energy, Office of Environment, Safety and Health, Office of Nuclear Safety, Washington, D.C., June 3, 1994.

2. *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, Volume 2: Appendixes, EH-12-94-01, U. S. Department of Energy, Office of Environment, Safety and Health, Office of Nuclear Safety, Washington, D.C., June 3, 1994.

3. National Academy of Sciences (NAS). *Health Effects of Exposure to Low Levels of Ionizing Radiation*. BEIR V, Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences, Washington, D.C., 1990.

4. *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Revision 0, U. S. Department of Energy, Richland Operations Office, Richland, Washington, February 1996.